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United States Patent [19]**Mackinlay et al.**[11] **Patent Number:** **5,737,115**[45] **Date of Patent:** **Apr. 7, 1998**[54] **ADDITIVE COLOR TRISTATE LIGHT VALVE TWISTING BALL DISPLAY**[75] Inventors: **Jock D. Mackinlay**, Palo Alto;
Maureen C. Stone, Los Altos, both of Calif.[73] Assignee: **Xerox Corporation**, Stamford, Conn.[21] Appl. No.: **573,922**[22] Filed: **Dec. 15, 1995**[51] Int. Cl.⁶ **G02B 26/00**[52] U.S. Cl. **359/296**; 345/107; 345/108;
345/111; 349/112; 349/117; 349/188; 427/214[58] Field of Search 359/296, 298;
345/111, 107, 108; 364/4, 5, 7, 8, 15; 427/214,
282; 349/112, 142, 87, 94, 117, 188[56] **References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—Loha Ben*Attorney, Agent, or Firm*—Alexander E. Silverman[57] **ABSTRACT**

A tristate light valve ball for an electrical twisting ball device composed of spheroidal balls rotatably disposed in an elastomer substrate. The ball is composed of segments arrayed substantially parallel to one another, each segment being adjacent to at least one other segment and to no more than two other segments. Adjacent segments are adjoined to one another at substantially planar interfaces. The segments include: a first, interior, nontransparent segment having a first optical modulation characteristic; a second exterior, transparent segment, adjacent to the first segment and having a second optical modulation characteristic; a third, interior, nontransparent segment having a third optical modulation characteristic; and a fourth, exterior, transparent segment adjacent to the third segment. For example, the ball can be made with a black first segment adjacent to a white third segment, surrounded on either side by clear second and fourth exterior segments. The ball has an anisotropy for providing an electrical dipole moment, the electrical dipole moment rendering the ball electrically responsive such that when the ball is rotatably disposed in a nonoscillating electric field while the electrical dipole moment of the ball is provided, the ball tends to rotate to an orientation in which the electrical dipole moment aligns with the field. Also disclosed are: a material made up of a substrate layer in which are disposed the aforementioned balls, with a colored backing joined to a rear surface of the layer; and a method for using a device incorporating the balls.

20 Claims, 32 Drawing Sheets